EASTMOUNT ENVIRONMENTAL SERVICES
Air Quality Specialists

FINAL REPORT

VOC and VOC HAP Emissions Testing from Asphalt Storage Tank No. 2 Tank Headspace and Loading Operations at Sprague's Searsport, Maine Terminal

Test Dates: May 7-22 and June 20-21, 2013

Prepared for . . .

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1.0 INTRODUCTION

1.1 General

Eastmount Environmental Services, LLC of Newburyport, MA was retained by Sprague Operating Resources LLC of Portsmouth, NH to conduct emissions testing at their Searsport, Maine terminal. Testing was conducted to establish the emission rate of volatile organic compounds (VOC) and VOC hazardous air pollutants (VOC HAP) from the headspace emissions of Asphalt Storage Tank No. 2, as well as emissions from storage tank and tanker truck loading operations

Testing was conducted in response to an EPA testing order for information under Section 114 of the Clean Air Act which was received by Sprague on September 27, 2011 and in accordance with testing approaches subsequently prescribed by USEPA Region I staff.

Testing on the Asphalt Storage Tank No. 2 commenced on May 7, 2013, and was concluded on May 22, 2013. Headspace VOC emissions were measured continuously throughout this period. The Vessel Transfer Test occurred on May 9-10, 2013. The Loading Rack Test, during which nine tanker truckers were loaded with asphalt, occurred on June 20-21, 2013.

Please note that, for the purposes of this program, volatile organic compounds (VOC) are also referred as non-methane hydrocarbons (NMHC). NMHC are determined by measuring total hydrocarbons (in terms of propane) using EPA Method 25A, and methane using EPA Method 18 concurrently. Methane lb/hr emissions are subtracted from the total hydrocarbon lb/hr emissions to obtain NMHC lb/hr emissions. This is not to be confused with VOC HAP which are individual (rather than total) volatile organic compounds that are considered to be hazardous air pollutants (HAP) by the USEPA. VOC HAP are measured by EPA Method TO-15.

A summary of the primary parties involved in this test initiative is presented in Table 1-1. A summary of test parameters and methods applicable to this program can be found in Table 1-2.

1.2 Program Overview

The objective of the emission test program was to gather VOC and HAP emissions information from an asphalt storage tank and associated tanker trucks under a variety of test scenarios as prescribed by EPA Region I staff. The following summarizes the program objectives.

1) Storage Tank 15-Day VOC Sampling – The VOC concentration and emission rate of Asphalt Storage Tank No. 2 was continuously monitored and logged over a 15-day period at the outlet of the TTE exhaust system that was fitted over the single exhaust vent on the storage tank roof. VOC measurements commenced two days prior to the beginning of the transfer of asphalt from the vessel to the storage tank, and then continued during and after the tank filling process to collect a total of fifteen days of continuous emissions data. EPA Methods 18 (methane) and 25A (total hydrocarbons) were utilized for VOC sampling. Final results were reported in terms of non-methane hydrocarbons (NMHC) in which methane is subtracted from total hydrocarbons on a lb/hr basis. Concurrent with VOC sampling, volumetric flow rate was measured continuously using a pitot tube/pressure transducer/thermocouple system. The data was logged continuously on a computer. Flow data was used to calculate VOC and HAP mass emissions.

2) Storage Tank VOC Sampling During Vessel Transfer – VOC concentration and emission rate from the storage tank were quantified as a vessel offloaded approximately 49,971 barrels of asphalt into the tank over a 13-hour period. The VOC concentration was measured in accordance with EPA Methods 18 and 25A at the outlet of the TTE exhaust system. Volumetric flow data was obtained by calculating the cubic feet per hour of air displaced from the tank vents, based on the hourly asphalt transfer rate from the vessel into the storage tank. Volumetric flow data was used to calculate the hourly VOC mass emission rate from the storage tank vents during this process.

3) Tanker Truck VOC Sampling – The VOC concentration and emission rate from truck loading operations were quantified during nine valid filling cycles. The headspace VOC concentration of the tanker was measured in accordance with EPA Methods 18 and 25A while the tanker was being filled with asphalt. Sampling occurred just inside the tank fill hatch using a stainless steel probe equipped with a filter cartridge at the tip of the probe, a coalescing filter, a heated filter, and heated sample line that delivered the sample to the analyzer. Tank exhaust volumetric flow rate was calculated based on the asphalt fill rate of the truck in gallons per hour, and the resultant displacement of air in cubic feet per hour. This data was used to calculate VOC mass emissions from truck loading operations.

4) VOC HAPS Sampling – A total of four Summa samples were collected during this program – two during normal tank static breathing, one during vessel transfer, and one during truck loading. Samples were collected in prepared Summa canisters, and were analyzed for VOC Hazardous Air Pollutants (HAP) in accordance with EPA Method TO-15. Each Summa sample was analyzed for the VOC HAP compounds identified in EPA Method TO-15. Additionally, the largest 20 tentatively identified compounds (TIC) were quantified. Results are reported in units of concentration (ug/M3) and mass emission rate (lb/hr).

1.3 Technical Approach to Sampling

1.3.1 Storage Tank Sampling – Static Breathing

One of the unique challenges of this program was to quantify representative VOC mass emissions from the Storage Tank vent as it would naturally vent or out-gas. Whereas measuring VOC concentration in the exhaust vent was fairly straightforward, measuring exhaust volumetric flow rate from the tank vent during idle periods was difficult since the flow rate of the tank vent was extremely low and likely to be undetectable using conventional EPA Method 2 procedures.

The objective was to capture the vapors that naturally out-gas from the Storage Tank vent, while also achieving a measurable flow rate, but without inducing excessive draft across the vent opening. EPA has not promulgated an applicable test method for this measurement. Per EPA Region I staff direction, a Temporary Total Enclosure (TTE) Exhaust System was constructed around the single tank vent. The exhaust of the TTE was directed into an exhaust duct. The TTE was large enough to encapsulate the entire vent. The TTE was fitted with one natural draft opening (NDO) that had an adjustable damper to vary its size. The TTE exhaust duct was fitted with an exhaust fan. The purpose of the fan was: 1) to draw tank VOC emissions from the TTE into an exhaust duct where emissions were measured; 2) to achieve a measurable flow rate in the exhaust duct; and 3) to balance the static pressure in the TTE to approximately negative 0.10 inches water column (but never below negative 0.007 inches water column), thus achieving 100% capture of tank gases while minimizing the negative pressure of the TTE. The exhaust fan speed, the exhaust fan adjustable waste gate, and the NDO adjustable gate were varied to achieve this optimal set point during natural out-gassing.

All Storage Tank sampling took place in the exhaust duct prior to the ID fan. A small S-type pitot tube was securely mounted in the exhaust duct at a traverse point of average velocity, and the VOC sampling probe was securely mounted in the duct center and approximately two duct diameters downstream of the pitot tube. An S-type pitot was selected over a standard pitot to avoid clogging of the pitot openings. However, the pitot tip was fabricated with 3/16" stainless steel to minimize the size of the pitot.

The Method 25A/18 VOC/methane sample was collected from the TTE exhaust duct upstream from the exhaust fan. The sampling probe was swage-locked directly onto the sampling port to ensure a leak-free fitting. Two coalescing filters were installed at the base of the probe to remove any oil mists. A quartz fiber filter, heated to 275°F, was placed in-line between the coalescing filter and the heated sample line. The sample was transported to the VOC analyzer via approximately 100 feet of heated Teflon sample line (set at 275°F). The pitot and thermocouple were connected to a 250-foot flow line that was in turn connected to a pressure transducer/digital temperature readout. The signals from the VOC and methane analyzers and the pressure transducer/temperature readout were recorded on a data acquisition system (DAS) consisting of a data logging device and a computer. The DAS was programmed to collect data every 2 seconds, and record the data once every minute as an average of the thirty 2-second data points.

It should be noted that the addition of the coalescing filters just after the probe was needed to prevent oil mist from contaminating the sampling system and ruining the analyzer. During previous sampling on an asphalt storage tank, condensed oil was observed to be seeping out of the VOC analyzer bypass, which resulted in the complete rebuilding of the analyzer. Eastmount installed the coalescing filters, and demonstrated that they had negligible bias on the sample data by first sampling with the coalescing filters installed, for a 24-hour period, and then removing the filters and allowing the system to sample for approximately 5 minutes. No changed was observed in the concentration. EPA Region 1 personnel reviewed this process change on site and approved the use of the filters.

Throughout the testing period, any anomalies in the testing or process operations were immediately reported to the Eastmount Project Director, who then contacted the EPA.

Testing was conducted in strict accordance with the approved Pretest Protocol, the EPA Quality Assurance Handbook for Air Pollutant Measurement Systems – Vol. III, and the applicable EPA Methods as found in 40 CFR 60, Appendix A, as amended.

1.3.2 Storage Tank Sampling – Vessel Transfer

During storage tank loading from the vessel, the flow and pressure dynamics of the TTE Exhaust System changed because air was displaced from the tank as it filled with asphalt. The TTE exhaust system flow rate was maintained at the same setpoint for static breathing, but the NDOs were completely shut to capture all displaced gas from the tank, and direct it to the exhaust duct. The calculated exhaust flow rate of tank air displaced by the transfer of asphalt from the vessel into the tank was used in the calculation of actual VOC emissions from the storage tank during the 13-hour vessel transfer period. The TTE exhaust system sampling location was still used to measure the VOC concentration.

1.3.3 Tanker Truck Sampling

VOC concentration was measured directly from the tanker truck filling hatch on the top of the tanker. A fuel oil filter, wrapped with fiberglass cloth, was securely attached to the end of an unheated length of 3/8" stainless steel to be used as a probe. Two coalescing filters were attached to the base of the probe to remove oil mist. A heated filter was placed in-line between the coalescing filters and the heated Teflon sample line, which then delivered the gas sample to the VOC analyzer. Care was taken to ensure that the probe tip did not come in contact with the asphalt in the truck. The fiberglass cloth was periodically replaced on the probe tip filter as it became coated with asphalt. The volumetric flow rate of air being displaced by the asphalt entering the tank was calculated based on the fill rate of each truck. This data was used to calculate the mass emissions of VOC.

1.4 Report Organization

The remainder of this Final Report is divided into four additional sections. The Summary of Results for the entire program in presented in Section 2. A description of the facility and sampling locations is presented in Section 3. Emissions monitoring equipment and procedures are described in Section 4. Section 5 addresses the quality assurance/quality control aspects of the program. All supporting field data, calculations, calibrations, test logs, and process data are appended to the Final Report.

Table 1-1 Test Program Informational Summary

Facility Corporate Information	
Corporate Organization:	Sprague Operating Resources LLC
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Phone:	(207) 548-2531
Test Firm Information	
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Table 1-2 Summary of Parameters and Test Methods

Test Location	Parameter	Test Method	Sampling Duration
Storage Tank Exhaust Vent	Total VOC (as propane)	EPA 25A	Continuous sampling over 15 days
	Methane	EPA 18	
	Volumetric Flow [1]	EPA 2C	Continuous sampling over 15 days
	VOC HAPS (TO-15 list plus the first 20 TICs [2])	EPA TO-15	1 Summa canister/week plus one Summa during tank filling (3 samples total)
	Capture (static pressure of TTE)	EPA Method 204	Verified daily
Tanker Truck Fill Hatch	Total VOC (as propane)	EPA 25A	Continuous sampling of 9 tanker truck filling cycles
	Methane	EPA 18	
	VOC HAPS (TO-15 list plus the first 20 TICs [1])	EPA TO-15	1 Summa canister during tanker truck filling
	Volumetric Flow	Calculated based on tank volume displacement	9 filling cycles

[1] Volumetric flow rate during Vessel Transfer was calculated based on tank volume displacement.

[2] Tentatively identified compounds

2.0 SUMMARY OF RESULTS

2.1 Overview

The following presents the results for VOC and HAP during both the Asphalt Test Program and the Residual Oil Test Program, and includes a discussion of observations made during the test procedures. Table 2-1 below provides an overall summary of the test results for the Asphalt Test Program. Table 2-2 summarizes the test results from the Residual Oil Test Program conducted at this facility in 2012. Table 2-3 summarizes the annual VOC (or non-methane hydrocarbon) emissions from asphalt sources at the Searsport, Maine Terminal over the last five years using the factors developed during the testing. Table 2-4 summarizes the annual VOC HAP emission from asphalt sources at the Searsport, Maine terminal over the last five years. This information is based on historical terminal activity and the VOC and VOC HAP emissions data collected during the May-June 2013 fifteen-day monitoring period, including static tank breathing, vessel transfer and truck loading activities.

The combined results of both the Asphalt and Residual Oil programs presented in Table 2-5. The results indicate that facility does not exceed the major source classification of 50 tons per year total VOC, 25 ton per total VOC HAP, or 10 tons per year of an individual VOC HAP. Therefore, Sprague is in compliance with the synthetic minor classification set forth in the facility air permit.

Table 2-1 Overall Summary of Test Results – Asphalt Storage Tank #2

Source	VOC	HAP
Tank Breathing (tons/year)	4.2	0.42
Vessel Transfer (lbs/hr)	0.78	1.04e-4
Truck Transfer (lbs/transfer)	0.037	2.56e-6

Table 2-2 Overall Summary of Test Results – Residual Oil Storage Tank #3

Source	VOC	HAP
Tank Breathing (tons/year)	10.6	1.7
Vessel Transfer (lbs/hr)	11.2	1.4
Truck Transfer (lbs/transfer)	0.4	0.1

Table 2-3 Facility VOC Emissions from Asphalt Sources

Summary Emissions Data - From Field Tests
Asphalt VOCs

Tank Breathing	4.3	tons/per year
Vessel Transfer	0.8	lbs/hour
Truck Transfer	0.037	lbs/transfer

	2008	2009	2010	2011	2012
Subtotal Truck Volume (gal)	15,646,680	9,741,564	6,894,174	12,553,716	8,882,383
# of Truck Loads (~7600 gal/load)	2,022	1,271	906	1,395	987
Truck Rack Emissions (tons)	0.04	0.02	0.02	0.03	0.02
Subtotal Vessel Volume (Bbls)	379,539	205,440	225,212	233,382	231,229
Transfer Time @4000 Bbls/hr (hrs)	95	51	56	58	58
Vessel Transfer Emissions (tons)	0.037	0.020	0.022	0.023	0.023
# Asphalt Tanks	1	1	1	1	1
Tank Breathing (tons)	4.29	4.29	4.29	4.29	4.29
Subtotal Calculated Asphalt VOC Emissions (tons)	4.4	4.3	4.3	4.3	4.3

Table 2-4 Facility VOC HAP Emissions from Asphalt Sources

Summary Emissions Data - From Field Tests
Asphalt HAPs

Tank Breathing	0.4	tons/per year
Vessel Transfer	1.04E-04	lbs/hour
Truck Transfer	2.56E-06	lbs/transfer

	2008	2009	2010	2011	2012
Subtotal Truck Volume (gal)	15,646,680	9,741,564	6,894,174	12,553,716	8,882,383
# of Truck Loads (~7600 gal/load)	2,059	1,282	907	1,652	1,169
Truck Rack Emissions (tons)	0.00	0.00	0.00	0.00	0.00
Subtotal Vessel Volume (Bbls)	379,539	205,440	225,212	233,382	231,229
Transfer Time @4000 Bbls/hr (hrs)	95	51	56	58	58
Vessel Transfer Emissions (tons)	0.00	0.00	0.00	0.00	0.00
# Asphalt Tanks	1	1	1	1	1
Tank Breathing (tons)	0.42	0.42	0.42	0.42	0.42
Subtotal Calculated Asphalt HAP Emissions (tons)	0.4	0.4	0.4	0.4	0.4

Table 2-5 Facility Emissions from #6 Oil and Asphalt Sources

Summary Facility VOC/HAP Emissions
Sprague Searsport

	2008	2009	2010	2011	2012
VOC					
#6 Oil	25.2	23.9	22.9	23.2	22.6
Asphalt	4.4	4.3	4.3	4.3	4.3
Subtotal VOC Emissions (tons/yr)	29.6	28.2	27.3	27.5	26.9
HAP					
#6 Oil	4.0	3.9	3.7	3.8	3.7
Asphalt	0.4	0.4	0.4	0.4	0.4
Subtotal HAP Emissions (tons/yr)	4.5	4.3	4.1	4.2	4.1

Note: Based on Actual Historical Activities

2.2 Discussion of Program Observations

This project was completed in accordance with the program objectives and the approved Test Protocol. Eastmount was able to adhere to EPA reference methodology throughout the program with regard to volumetric flow measurement, analyzer daily calibrations, VOC sample acquisition, and capture of VOC emissions. Daily post-test calibrations were conducted on the total hydrocarbon and methane analyzers which successfully demonstrated daily linearity throughout entire program. There was no evidence of significant velocity pressure transducer zero drift, and the pitot tubes never became heavily coated or clogged with oil mist. The static pressure of the TTE was maintained below -0.007 inches water column throughout the 15-day period.

2.2.1 Effect of Oil Mist on the Sampling System

As evidenced previous sampling programs on both asphalt and residual oil storage tanks, the sampling system has a tendency to become coated with condensed oil mist. This created problems during calibrations as exhibited by excessive time needed to reach acceptable zero and span gas readings. Furthermore, a VOC analyzer became heavily contaminated on a previous asphalt program. Therefore Eastmount was granted conditional approval to install a pair of oil mist-removing coalescing filters immediately after the sampling probe. The result of this sample train modification was significant reduction in the amount of time needed to achieve zero and span system response to calibration gas. Furthermore, Eastmount compared the instrument VOC response to tank exhaust gas with and without the coalescing filters inline over a brief period of time (5 minutes), and saw no discernible difference between the two configurations, confirming that the filters did not interfere with sampling output.

2.2.2 TTE Static Pressure and the Effect of Volumetric Flow on VOC Emissions

The representativeness of the 24-hour VOC emissions data collected from the storage tank over the 15-day period largely depends on the flow dynamics that were occurring inside the EPA Method 204 TTE Exhaust System that was temporarily erected around the tank's exhaust vent. The Protocol for sampling with this particular configuration was untested and unprecedented in this application. Whereas EPA Method 204 is well suited to capturing gases and fumes from indoor VOC coating applications, using this system to capture fumes from a passive ventilation source in an outdoor setting with typically windy conditions posed many challenges. In this case, the goal was to demonstrate 100% capture of tank off-gas without oversampling the passive ventilation system and thus creating additional emissions.

Wind from Penobscot Bay posed the greatest challenge in maintaining slight TTE negative pressure as there was frequently a strong sea breeze blowing across the single TTE natural draft opening (facing downward with the addition of a 90° elbow). Furthermore, there was a significant amount of visible water vapor being emitted from the exhaust vent, and this also affected the pressure of the TTE. Therefore, the TTE system exhaust fan speed was set to a maximum setting in order to maintain a negative static pressure in the TTE.

2.3 Summary of Results - VOC/HAP Asphalt Storage Tank Test Program

This section contains summary tables of VOC data collected over the 15-day period. Table 2-6 summarizes the daily non-methane hydrocarbon (NMHC) emissions results on Asphalt Storage Tank No. 2 over a 15-day period (May 7 through 22, 2013) during normal tank breathing. All supporting data and calculations are contained in Appendix A.

Table 2-7 summarizes NMHC emissions measured during a transfer of approximately 49,971 barrels (2,098,782 gallons) of asphalt from the vessel into Tank No. 2 over a 13-hour period on May 9 through 10, 2013. All supporting data and calculations are contained in Appendix B.

Table 2-8 summarizes the NMHC emissions measured at the truck loading rack on June 20-12, 2013 during nine valid filling cycles. All supporting data and calculations are contained in Appendix C.

Table 2-9 summarizes the VOC HAP emissions results (Summa sampling) during normal tank breathing. All supporting data and calculations are contained in Appendix D.

Table 2-10 summarizes the VOC HAP emissions results during vessel transfer operations. All supporting data and calculations are contained in Appendix D.

Table 2-11 summarizes the VOC HAP emissions results during truck loading operations. All supporting data and calculations are contained in Appendix D.

Table 2-6 Asphalt Tank Non-Methane Hydrocarbon Emission Summary – Static Tank Breathing

Sprague Searsport – May 7-22, 2013

Date	TTE #1 Pressure (In. w.c.)	Daily Cal Status	Tank Temp (°F)	Tank Capacity (%)	Volumetric Flow Rate (scfm)	Non-Methane Hydrocarbons (Lb/hr)	Non-Methane Hydrocarbons (Tons/year)
05/07/13	-0.015	Good	312	24	494	0.48	2.10
05/08/13	-0.024	Good	312	24	488	0.48	2.10
05/09/13	-0.041	Good	312	24	497	0.43	1.89
Vessel Transfer May 9 at 15:30 through May 10 at 04:06 - See Table 2-2							
05/10/13	-0.024	Good	289	76	485	0.56	2.46
05/11/13	-0.023	Good	290	76	500	0.34	1.51
05/12/13	-0.023	Good	294	76	496	0.33	1.43
05/13/13	-0.054	Good	295	75	514	0.59	2.59
05/14/13	-0.027	Good	297	74	497	1.15	5.04
05/15/13	-0.026	Good	300	73	505	1.23	5.37
05/16/13	-0.013	Good	301	73	474	1.48	6.48
05/17/13	-0.058	Good	306	72	498	1.26	5.52
05/18/13	-0.028	Good	307	72	494	1.28	5.60
05/19/13	-0.023	Good	306	72	492	1.40	6.11
05/20/13	-0.011	Good	308	71	491	1.43	6.25
05/21/13	-0.044	Good	310	71	495	1.46	6.38
05/22/13	-0.065	Good	308	71	503	1.47	6.44
AVERAGE:					**495**	**0.96**	**4.20**

Table 2-7 Asphalt Tank Non-Methane Hydrocarbon Emissions Summary – Vessel Transfer

Sprague Searsport – May 9-10, 2013

Hour No.	Start Time	End Time	Transfer Rate (barrels/hr)	Displ. Flow Rate (scfm)	Measured Flow Rate (scfm)	THC as C3H8 (lb/hr)	CH4 (lb/hr)	NMHC (lb/hr)	NMHC (tons/hr)
1	15:30	16:30	919	85	486	0.11	0.01	0.10	5.06E-05
2	16:30	17:30	4218	391	464	0.84	0.06	0.78	3.90E-04
3	17:30	18:30	4218	391	460	0.92	0.06	0.85	4.26E-04
4	18:30	19:30	4429	410	467	0.91	0.07	0.84	4.22E-04
5	19:30	20:30	4429	410	463	0.97	0.07	0.90	4.49E-04
6	20:30	21:30	4430	411	470	0.94	0.07	0.86	4.32E-04
7	21:30	22:30	4430	411	477	0.95	0.08	0.87	4.35E-04
8	22:30	23:30	4684	434	468	1.05	0.08	0.97	4.84E-04
9	23:30	0:30	4684	434	465	1.08	0.08	1.00	4.98E-04
10	0:30	1:30	4518	419	472	1.03	0.08	0.95	4.76E-04
11	1:30	2:30	4518	419	463	1.06	0.08	0.98	4.90E-04
12	2:30	3:30	2972	275	464	0.68	0.05	0.64	3.18E-04
13	3:30	4:06	1486	229	472	0.49	0.04	0.46	2.28E-04
Average:			**3841**	**363**	**468**	**0.85**	**0.06**	**0.78**	**3.92E-04**
Total Tons NMHC Per Vessel Transfer = 5.10E-03									

Note 1: One barrel = 5.56 cubic feet

Note 2: NHMC emisisons calculating using measured volumetric flow rate.

Note 3: One transfer takes approximately 12.5 hours.

Table 2-8 Asphalt Tank Non-Methane Hydrocarbon Emissions Summary – Truck Loading

Sprague Searsport – June 20-21, 2013

Truck No.	Start Time	End Time	Load Time (minutes)	Load (gallons)	Fill Rate (gal/hr)	Displacement (scfm)	NMHC (lb/hr)	NMHC (lb/load)	NMHC (Ton/load)
1 Void	3:49	4:05	16	7709	28909	64.4	Missed first half of load		
2	4:43	4:58	15	7915	31660	70.5	0.14	0.036	1.78E-05
3	7:11	7:25	14	7742	33180	73.9	0.19	0.044	2.22E-05
4	8:13	8:27	14	7740	33171	73.9	0.19	0.044	2.22E-05
5	12:26	12:40	14	7625	32679	72.8	0.23	0.051	2.55E-05
6	3:40	3:54	14	7676	32897	73.3	0.14	0.033	1.65E-05
7	4:03	4:17	14	7742	33180	73.9	0.13	0.029	1.47E-05
8 Void	7:33	7:47	14	7850	33643	75.0	Probe clogged with asphalt		
9	8:31	8:44	13	7466	34458	76.8	0.11	0.024	1.18E-05
10	8:53	9:05	12	6953	34765	77.5	0.36	0.073	3.63E-05
11	12:03	12:16	13	7443	34352	76.5	0.02	0.000	0.00E+00
Average:			**14**	**7624**	**32990**	**73.5**	**0.17**	**0.037**	**1.85E-05**

Note: One Gallon = 0.13368 cubic feet

Table 2-9 Asphalt Tank VOC HAP Emissions – Tank Breathing

Summa No.	Activity	Date	Time	Max HAP Compound	Max HAP (Tons/year)	Sum of HAP (Tons/year)	Sum of TICs (Tons/year)
1	Breathing	5/8/13	1600-1630	2-Propanone	1.40E-01	4.87E-01	2.59E-01
3	Breathing	5/17/13	1355-1415	Propene	7.67E-02	3.49E-01	4.43E-01

Table 2-10 Asphalt Tank VOC HAP Emissions – Vessel Transfer

Summa No.	Activity	Date	Time	Max HAP Compound	Max HAP (lb/hr)	Sum of HAP (lb/hr)	Sum of TICs (lb/hr)
2	Vessel Transfer	5/10/13	0305-0335	2-Propanone	2.99E-05	1.04E-04	3.89E-02

Table 2-11 Asphalt Tank VOC HAP Emissions – Truck Filling

Summa No.	Activity	Date	Time	Max HAP Compound	Max HAP (lb/transfer)	Sum of HAP (lb/transfer)	Sum of TICs (lb/transfer)
4	Truck Loading	6/20/13	0720-0721	Propene	3.34E-07	2.56E-06	1.48E-02

3.0 PROCESS DESCRIPTION AND SAMPLING POINT CONFIGURATION

3.1 Facility Description

Sprague began operations at the Searsport facility in the early 1900's when it was used for the storage of bulk steam coal. The terminal is now a multi-use facility that handles bulk liquid cargoes, dry bulk products, and special heavy lift projects. Petroleum product storage includes No. 2 fuel oil, No. 6 fuel oil, ultra low sulfur diesel, and asphalt. In addition, Sprague transfers Irving products (gasoline, No. 2 oil, diesel, kerosene and asphalt) from Irving vessels through pipe lines to their terminal, located to the east of Sprague's property.

The Searsport Terminal has a total of nineteen (19) aboveground oil storage tanks. The total oil storage capacity of the terminal is 1,150,449 barrels, or 48,318,844 gallons. Approximately 5000 barrels of product are transferred through the facility on a daily basis. An estimated 30-40 tank trucks are loaded on a daily basis.

Products are primarily delivered to the Searsport Terminal by barges, tankers and ships. The terminal is staffed 24 hours per day, 365 days per week.

3.2 Sampling Location Description

3.2.1 Asphalt Storage Tank

Emissions from Asphalt Storage Tank No. 2 were quantified from the single exhaust vent on the tank roof. A Temporary Total Enclosure (TTE) was constructed around the vent such that the TTE completely encapsulated the vent. The TTE was equipped with a single natural draft opening (NDO) with a variable damper, and an exhaust duct of 7 inches inside diameter. The exhaust duct had a straight length of well over twenty duct diameters before connecting to an induced draft fan with and operating range of approximately 350 to 800 acfm. A waste gate was located just prior to the ID fan and two duct diameters downstream from the sampling ports. The duct flow rate was primarily controlled by adjusting the waste gate opening. The fan speed could be further adjusted by changing the diameter of the belt pulleys. During normal tank breathing, the flow rate of the TTE system was adjusted to the highest possible setting in order to maintain a TTE static pressure of at least negative 0.007" w.c. or more negative, thus achieving 100% capture in accordance with EPA Method 204. The TTE was equipped with a Dwyer digital static pressure measuring device that was used to verify the TTE static pressure on a daily basis.

All emissions measurements were made in the common exhaust duct prior to the ID fan. The duct was equipped with two national pipe thread (NPT) sampling ports located 90° apart for volumetric flow measurements, and two additional NPT ports located 90° apart for collecting VOC samples.

Figure 3-1 presents a general diagram of the Tank vent and the TTE Exhaust System. Figure 2-2 provides an image of the TTE Exhaust System in place on Tank No. 2. Table 2-1 lists the exhaust duct dimensions and corresponding flow traverse points. All dimensions were verified prior to sampling.

3.2.2 Tanker Truck Exhaust Vent

During tanker truck filling at the loading rack, VOC emissions were measured at the tanker truck fill hatch. A continuous gas sample was collected just inside the fill hatch during filling operations. Flow rate was not directly measured, rather it was calculated based on the fill rate of the tank and the resultant displacement of air.

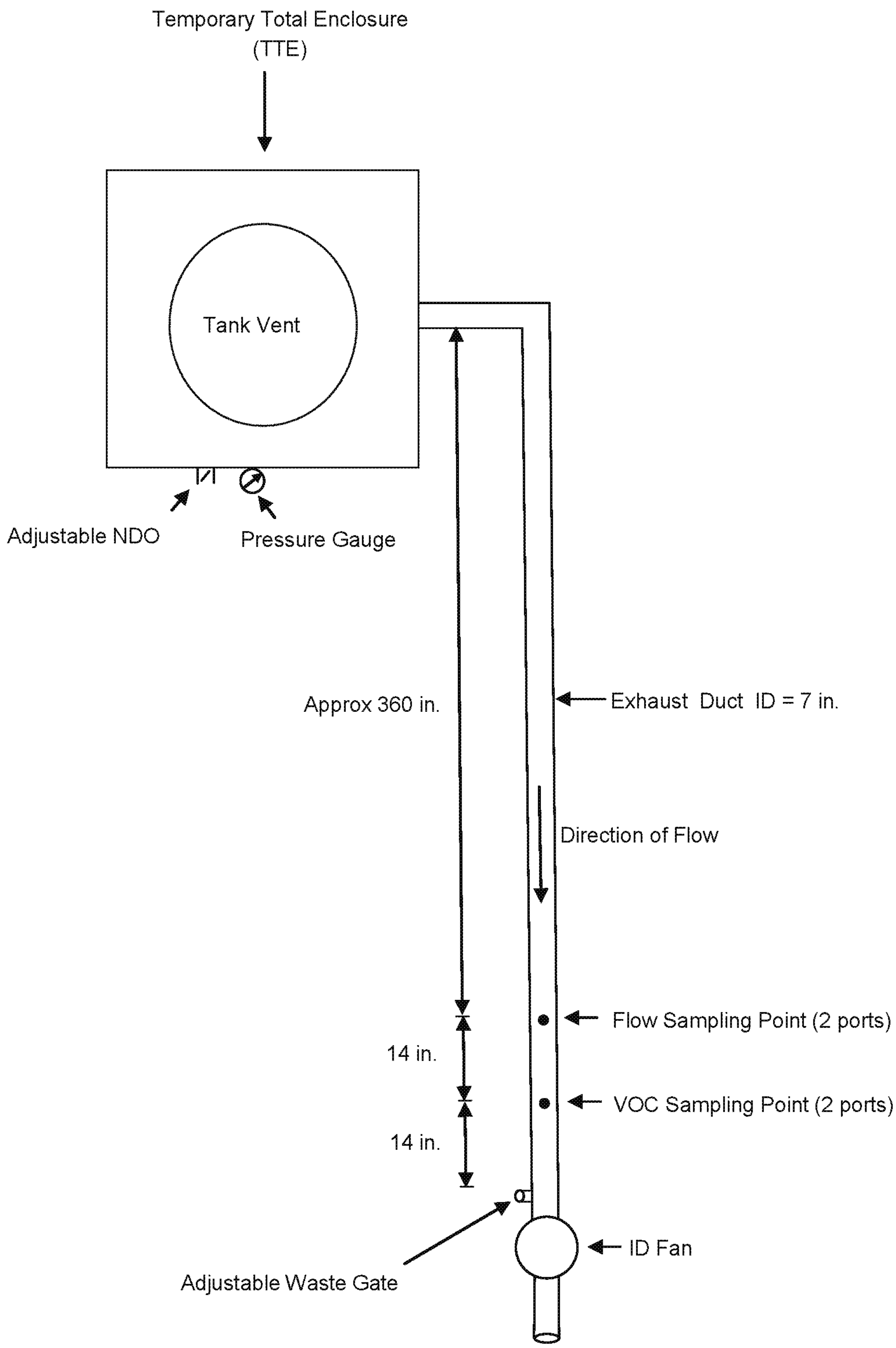
Temporary Total Enclosure (TTE)
Tank Vent
Adjustable NDO
Pressure Gauge
Approx 360 in.
Exhaust Duct ID = 7 in.
Direction of Flow
Flow Sampling Point (2 ports)
14 in.
VOC Sampling Point (2 ports)
14 in.
ID Fan
Adjustable Waste Gate

Figure 3-1 Asphalt Storage Tank No. 2 TTE Exhaust System Diagram

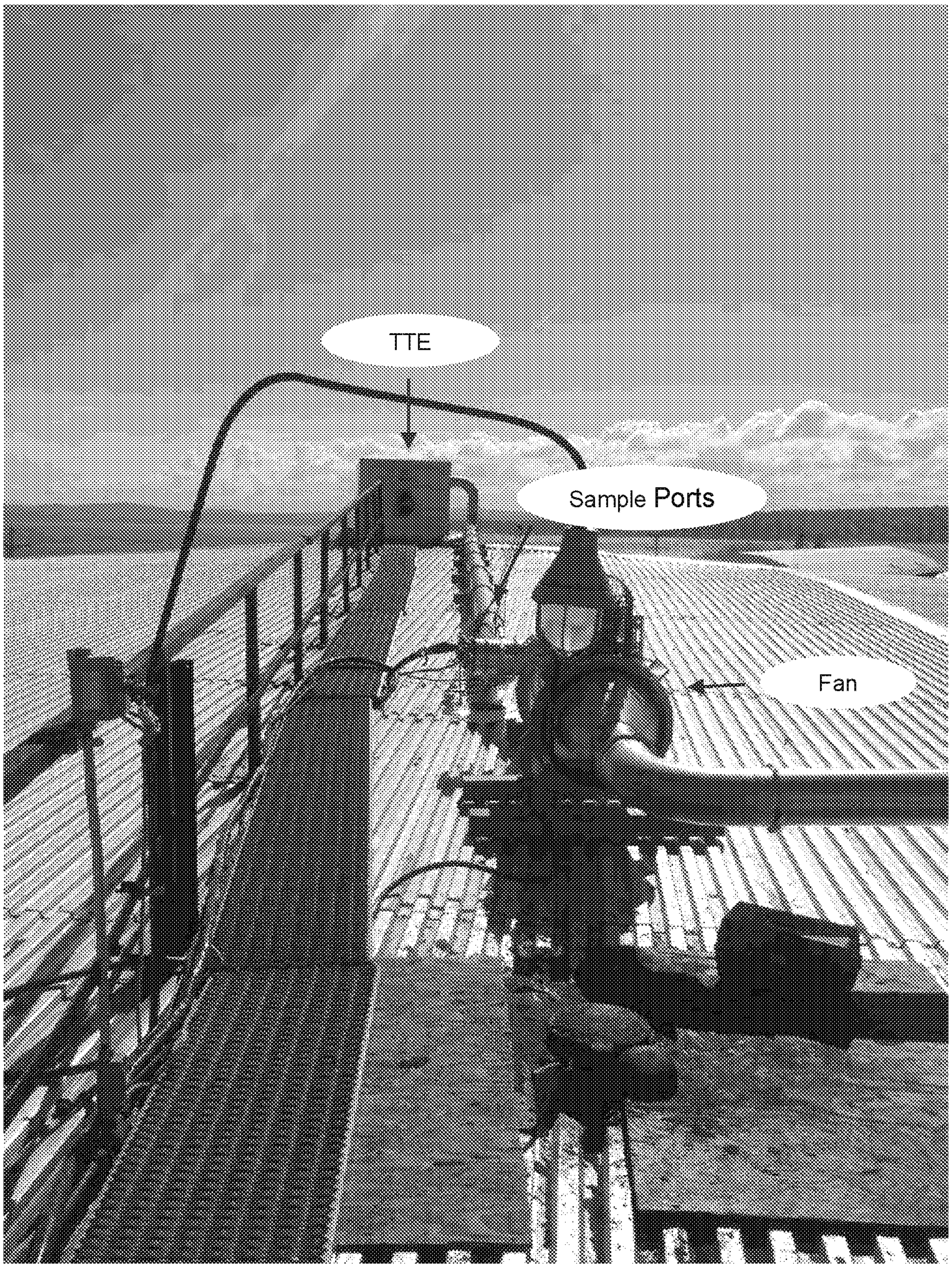

Figure 3-2 Asphalt Storage Tank No. 2 TTE Exhaust System

Table 3-1 Sampling Location – TTE Common Exhaust Duct

– Exhaust Duct Flow Sampling Location –		
Description	**Distance**	**Equivalent Diameters**
From nearest upstream disturbance to sampling ports	Approx. 360 inches	Approx. 51
From nearest downstream disturbance to sampling ports	14 inches	2.0
Diameter	7 inches	NA
Number of Ports	2	NA
Flow Traverse Points on a Diameter		
Traverse Point No.	**% of Diameter**	**Distance from Inside Wall**
1	6.7	0.5 inches
2	25.0	1.8 inches
3	75.0	5.3 inches
4	93.3	6.5 inches

Notes:

- **VOC and HAP were sampled at a single point in the duct center, 2 diameters downstream from the pitot tube.**
- **Velocity and temperature were measured at a single point in the duct that most closely matched the average velocity obtained during the velocity traverse.**
- **All dimensions were verified prior to sampling.**

4.0 TEST PROCEDURES

4.1 Overview

Emissions testing was conducted to determine the VOC and HAP concentration and mass emission rate of the subject process. Each parameter was measured in strict accordance with official EPA procedures at the sampling locations previously described. This section details the test procedures that were used during this test program.

4.2 Methodology

4.2.1 Non-Methane Hydrocarbons (NMHC) – EPA Methods 25A and 18

Non-methane hydrocarbons (NMHC) were measured at the storage tank exhaust vent and the tanker truck open hatch. NMHC consisted of measurements of total hydrocarbons (THC) determined in accordance with EPA Method 25A, and methane (CH_4) determined in accordance with EPA Method 18. Eastmount met the requirements of Methods 25A and 18 by utilizing one VIG Model 200 total hydrocarbon/methane analyzer equipped with a flame ionization detector (FID) for total hydrocarbons, and a methane-specific gas chromatograph (GC) also utilizing an FID.

The THC portion of the analyzer was initially calibrated with zero air and three certified standards of propane-in-balance-air at the beginning of the sampling program, and re-calibrated as necessary throughout the 15-day program. On a daily basis, zero air and an upscale propane standard were introduced to the analyzer through the entire system to determine system drift and accordingly, the validity of the data collected following the previous daily calibration check. All calibrations were performed in accordance with Method 25A and met or exceeded Method 25A accuracy criteria. All data was logged on a computer.

The methane gas chromatograph portion of the analyzer was calibrated in accordance with EPA reference Method 18. Eastmount utilized an internal gas chromatograph (GC) column in the VIG Model 200 to determine methane concentrations. The system was initially calibrated using zero air and three certified standards of methane-in-balance-air introduced to the GC. The GC was fully calibrated at the beginning of the sampling program, and thereafter as required. On a daily basis, zero air and an upscale methane standard were introduced to the analyzer through the entire system to demonstrate system drift and to validate sample integrity. Please note that although methane sampling is considered to be continuous, a methane sample injection occurs on a three-minute cycle.

All data was logged on a data acquisition system (DAS) consisting of an Iotech DAQ 56 data logger and a computer. Concentration data was recorded by the DAS in two-second intervals, and reported in one-minute averages.

4.2.2 Volumetric Flow Rate (EPA Methods 1-4)

Volumetric flow rate was measured from the storage tank TTE exhaust vent in accordance with EPA Method 2C. Eastmount used an S-type pitot tube manufactured by Apex Instruments. It was constructed of 3/16" tubing to minimize its size within the duct. A K-type thermocouple was incorporated into the pitot assembly which was encased in a leak-free ½" stainless steel sheath. This sheath was necessary to allow permanent installation of the pitot tube at the point of average velocity without allowing ambient air from entering the exhaust duct. The pitot tube was connected to a calibrated pressure transducer manufactured by Apex Instruments, with a range of 0 to 5 inches sensitivity, via 250 feet of tubing to measure the exhaust duct flow rate during both idle periods (no fuel being transferred), and also during fuel transfer periods. Additionally, flow rate was calculated during tank filling using the theoretical amount of air being displaced during fuel transfer into the tank.

Eastmount conducted an initial flow traverse at all traverse points. The pitot tube/thermocouple was then fixed in position at a traverse point that most closely matched the average duct velocity. The pitot tube was periodically removed to be inspected, cleaned if necessary, leak checked, and re-positioned in the duct. At no time during this program did the pitot system develop a leak, become clogged, or become dislodged from its intended position in the duct.

The molecular weight and moisture of the gas in the exhaust duct was assumed to be ambient during normal storage tank off-gassing since the majority of the gas entering and leaving the TTE was ambient air.

Volumetric flow rate data was logged on a data acquisition system (DAS) consisting of an Iotech DAQ 56 data logger and a computer. Flow data consisting of velocity pressure and temperature were recorded by the DAS in two-second intervals, and reported in one-minute averages.

4.2.3 VOC HAPS - EPA TO-15

VOC hazardous air pollutants (HAPS) were determined by collecting a sample in a prepared, pre-evacuated Summa canister with a calibrated flow orifice meter to allow canister filling for approximately 30 minutes. The sample was delivered to the canister via a short length of ¼" OD Teflon tubing and a short ¼" stainless steel probe which was positioned in the duct center using a leak-free Swagelok fitting. A total of four Summa samples were collected during this program – two during normal tank breathing, one during vessel transfer, and one during truck loading.

Maxxam Analytics of Burlington, Ontario conducted the final analysis of the Summa canisters in strict accordance with EPA Method TO-15. Analysis of VOC HAPs were determined by Gas Chromatography / Mass Spectrometry (GC/MS). The analytes consisted of the standard TO-15 list of VOC HAPs, plus the first 20 tentatively identified compounds (TICs). Results were reported in units of concentration and mass emissions for each compound.

4.2.4 Temporary Total Enclosure (TTE) System – EPA Method 204

A temporary total enclosure (TTE) was constructed around the single exhaust vent on Asphalt Storage Tank No. 2. The purpose of this approach was to capture vapors breathing from the tank vent, and deliver them to a common sampling location at a velocity that was measurable using EPA Method 2C equipment. The TTE fully covered the exhaust vent. The TTE was equipped with a single adjustable natural draft opening (NDO) and an exhaust duct. The exhaust of the TTE was connected to an exhaust duct equipped with sampling ports, an adjustable waste gate, and an exhaust fan.

The static pressure of the TTE was measured using a Dwyer Model DM-1123 digital low pressure gauge with a range of -0.5 to 0.5 inches w.c., and a resolution of 0.001 inches. The gauge was located on the side of the TTE. The positive pressure tap was fitted with a flexible Tygon tube that was positioned inside the TTE. The negative pressure tap was left opened to atmosphere, but was protected from the wind using a shield. The static pressure of the TTE was maintained at negative 0.007 inches water column (w.c.) or more negative in order to achieve 100% capture. The static pressure was measured daily, and recorded on the daily check list.

4.2.5 Test Log / Daily Activities

Eastmount maintained a test log consisting of daily equipment checks and calibrations throughout the 15-day test program. The log served to document all testing, calibration and QA/QC activities. As this program occurred over an extended period of time, it was essential to conduct calibrations and other equipment inspections on a daily basis. Daily calibrations and equipment checks were recorded on field data sheets which can be found in Appendices A3 and A4. Please refer to Section 5.2 of this protocol for a complete summary of daily onsite QA/QC activities.

4.3 Description of VOC and Methane Sampling

4.3.1 VOC and Methane Sampling System

What follows is a description of the transportable continuous emissions monitor system used to quantify VOC and methane emissions. The system meets all the specifications of Reference Method 18 and 25A:

- **Probe** - A short length (4 inches) of stainless steel probe was used at the sampling location. The probe was of sufficient length to reach the centroidal area of duct.

- **Coalescing Filters (2)** - A pair of coalescing filters were installed in-line between the probe and heated filter/calibration Tee. The purpose of the coalescing filters was to remove oil mist from the gas stream to protect the sample line surface and the VOC analyzer from oil coating.

- **Calibration Tee** - Stainless steel tee (3/8") located between the probe and the sample line allowed the operator to inject calibration gas through the entire sampling system. Excess calibration gas exits the probe, eliminating any potential over pressurization.

- **Heated Filter** - A heated, spun-glass fiber filter contained in a heated sheath was used to remove particulate from the gas stream. The filter was located between the sample probe and sample line. It is designed to remove particulate from the gas stream. The filter was heated to 275°F.

- **Heated Sample Line** - A heated 3/8" OD Teflon sample line was used to transport the sample stream from the test location to the analyzer. The line was heated to approximately 275°F to prevent condensation of gaseous hydrocarbons before reaching the analyzer.

- **System Calibration Line** - A ¼" OD Teflon tube was used to transfer calibration gas from the cylinder to the calibration tee between the probe and filter.

- **Sample Pump** - A leak-free pump (integrated into the VIG analyzer) was used to pull the sample gas through the system at a flow rate sufficient to minimize the response time of the measurement system. The components of the pump that contact the gas stream are constructed of stainless steel or Teflon. The sample pump was heated to 275°F to prevent condensation.

- **THC Analyzer –** One VIG Model 200 flame ionization analyzer (FIA) was used.

- **Data Acquisition System (DAS) –** The VOC analyzer's response was recorded on a Dell Vostro 1710 computer working in unison with an Iotech Data Acquisition System. This system was programmed to collect a data point every 2 seconds, and report/save the data in one-minute averages to the Iotech software. This software operates in a Windows environment.

4.3.2 VOC and Methane Sampling Procedures

Both the THC FID and the methane GC were initially calibrated using zero air plus low, mid and high propane-in-air (THC FID) and methane-in-air (methane GC) calibration gases, certified in accordance with EPA Protocol procedures. Calibrations were conducted through the entire sample system. A description of the specific procedures is provided below:

- **Zero:** The zero point of the analyzer was determined using a pre-purified cylinder of air. The zero point was analyzed for a minimum of five minutes to monitor drift before sampling commences.
- **High:** The high calibration gas was 80-90% of span. It was introduced to the sample system and the response of the analyzer was adjusted accordingly.
- **Low:** The low calibration gas was 25-35% of span. It was introduced to the sample system and the response of the analyzer was recorded.
- **Mid:** The mid calibration gas was 45-55% of span. It was introduced to the sample system and the response of the analyzer was recorded.

Once the analyzer was calibrated, the system was switched to sample mode and sampling commenced. The response time of the system was determined from the time the gas valve was shut off to the time the response of the FIA is 95% of the steady state sample value. The DAS then recorded the analyzer response throughout the test run. On a daily basis, the sampling system was post-calibrated. The post calibration consisted of delivering zero and a representative upscale calibration point through the entire sampling system and recording the system response. This response was used in conjunction with the initial system calibration in order to determine calibration drift over the test run period. If the analyzer drift was within the 3% of the measurement range, then the data collected between the previous and current calibrations was considered valid. If the analyzer drift was outside 3% of the measurement range, then the data would have been voided, and an entire system recalibration (zero and three upscale points) would have occurred.

4.4 Reference Method Volumetric Flow Determination

In conjunction with VOC monitoring, Eastmount continuously measured volumetric flow in accordance with EPA Methods 1-2C, 40 CFR 60, Appendix A. The following is a description of the individual components that comprised the sampling train.

4.4.1 Volumetric Flow Rate Equipment

Eastmount conducted volumetric flow rate determinations during this test program in accordance with procedures delineated in EPA Methods 1 and 2C, 40 CFR 60, Appendix A. The system components necessary to conduct this testing are detailed below:

- **Pitot Tube** - A small S-type pitot tube (constructed of 3/16" tubing) was used to measure gas velocities. A pitot coefficient of 0.84 was used.
- **Pitot Lines** - The pitot tube was connected to a pressure transducer via a 250-foot, leak-free flow line also equipped with thermocouple wire.
- **Pressure Transducer** - A pressure transducer, manufactured by Apex Instruments, with a range of 0-5" w.c. and a 0.01" w.c. sensitivity, was used to measure the velocity pressure drop.
- **Thermocouple** - A "K" type thermocouple was used to monitor the gas temperature.
- **Static Pressure** - Duct static pressure was measured by rotating the pitot tubes perpendicular to the direction of flow, disconnecting the negative pitot (if positive) and recording the deflection of the manometer.
- **Barometric Pressure** - The barometric pressure was obtained daily from the National Weather Service for the Searsport, ME area.

4.4.2 Volumetric Flow Rate Sampling Procedure

The following describes the procedure used to measure flow rate from the storage tank exhaust duct:

1. Assemble pitot tube, flow line, and pressure transducer. Mark the pitot tube with the appropriate traverse points.
2. Conduct a leak check on the system as follows: (a) blow through the pitot impact opening until at least 3.0 in. H_20 velocity head registers on the pressure transducer display, and close off the impact opening. The pressure shall remain stable for at least 15 seconds; (b) do the same for the static pressure side, except using suction to obtain the minimum of 7.6 cm (3.0 in.) H_20.
3. Conduct a preliminary traverse of the exhaust duct with the TTE/ID fan system operating normally. Record the velocity pressure and temperature at each location.
4. Position the pitot tube/thermocouple at the traverse point that most closely matches the average velocity pressure, and lock it into position.
5. Commence recording flow and temperature data.

6. Inspect, leak check and re-zero the system as required. This procedure was carried out weekly by Eastmount onsite personnel.

5.0 QUALITY ASSURANCE/QUALITY CONTROL

5.1 Overview

Sampling was conducted by trained personnel with extensive experience in Reference Method sampling. All sampling and analysis was conducted in strict accordance with EPA test procedures. The quality control procedures found in the EPA Quality Assurance Handbook for Air Pollution Measurement Systems were adhered to as well.

Eastmount Environmental Services, LLC has established and implements a Quality Management System that conforms to all of the requirements of the ASTM 7036 D - 04 quality standard entitled “Standard Practice for Competence of Air Emission Testing Bodies (AETB)”. A copy of the company’s AETB Certification Statement is available on request. The company has also developed a Quality Policy Statement confirming management’s commitment to undertake its scope of services in full conformance with all aspects of its Quality Management System and the ASTM D7036-04 practice standard. Further, the company has defined a set of Quality Objectives as part of its Quality Policy Statement that serve as the basis for maintaining the highest level of quality in its day-to-day testing and calibration initiatives. This program was carried out in full accordance with the company’s Quality Management System.

All of Eastmount’s field testing staff are nationally certified as Qualified Stack Testing Individuals (QSTI). Specifically, the Eastmount Project Director for this program is certified in all four groups associated with the QSTI certification program. The QSTI certification is recognized by EPA as the officially designated standard of expert air emissions testing acumen. It confirms that an individual demonstrates the knowledge and ability to carry out source testing and fundamental air quality engineering to the highest standards.

All calculations were conducted in strict accordance with the equations found in the individual Methods. Strict QA/QC protocols were followed during all phases of this project. These protocols included:

- QA objectives for measurement data;
- Data reduction;
- Internal QC;
- Calibration of equipment;
- Corrective action, if necessary; and
- Use of standardized field data sheets.

These specific procedures in addition to Eastmount's usual high standard of quality control will help validate the results obtained in this test program. As the majority of our emissions testing work is done for compliance purposes, strict QC procedures are incorporated into our everyday work performance.

5.2 Daily Onsite QA/QC Activities

The following section describes the onsite QA/QC activities that occurred on a daily basis throughout the program. Eastmount provided training to Sprague personnel to specifically carry out the required daily procedures. All activities were entered onto standardized field data sheets that were used to log equipment checks and calibrations.

5.2.1 VOC Analyzer

The total hydrocarbon analyzer was initially fully calibrated using the procedures defined in Sections 4.3.2 and 5.3.4 of this report. This consisted of first zeroing the analyzer(s) through the entire system with UHP air, spanning the instrument(s) with a high calibration gas of 80-90% of instrument range, and then introducing two additional gases at 45-55% and 25-35% of analyzer range.

On each day of the 15-day sampling period, zero gas and a single upscale gas were introduced to the system to verify that the system calibration was within the tolerance of EPA Method 25A. These daily post-calibrations were conducted to demonstrate that the system response had not drifted from the initial calibration by more than 3% of the sampling range of the analyzer. A pass/fail range was calculated by Eastmount based on the most recent initial calibration results, allowing the operator to quickly determine the status of the daily calibration.

All calibration data, including the operator name, date/time, calibration gas concentrations, and calibration status (pass/fail) were documented on the daily calibration data sheets that can be found in Appendix A3. Calibration data values that were logged onto the daily data sheet were entered into a spreadsheet to validate the data collected during each 24-hour period. Any anomalies (analyzer drift, analyzer recalibration, malfunctions such as analyzer flame-out, etc.) were cited in the log, and were immediately reported to the EPA. During this program, there were no issues regarding analyzer drift, analyzer recalibration, analyzer flameout, or heated sample line/filter failure.

5.2.2 Coalescing Filters

As part of the daily equipment check, both coalescing filters were opened and examined for the presence of visible oil and/or moisture collection. The first (No. 1) coalescing filter cartridge element was replaced on a daily basis. The second (No. 2) coalescing filter cartridge was replaced on every third day. Only after the 13-hour vessel transfer was some moisture (approximately 1 ml) present in Coalescing filter No. 1.

5.2.3 Flow Monitor

The pitot tube and pressure transducer system was inspected on a weekly basis. The pitot tube was removed from the exhaust duct and inspected to ensure that the pitot openings were clear and free of condensed oil or other contaminants. The pitot system was leak checked by pressurizing the positive line, sealing it, and observing a steady transducer reading for 15 seconds. The negative line underwent the same leak check procedures under negative pressure. Once leak checking was completed, the pitot system was re-zeroed (if needed), and the pitot was returned to the traverse point of average velocity. Any anomalies (clogged pitot, leak in the system, etc.) were recorded on the test log, and reported to the EPA. During this program, there were no issues regarding pitot leaks, significant zero drift, clogging of the pitot openings, or significant coating of the pitot head.

5.2.4 TTE Pressure

The static pressure of the TTE was checked and recorded in the Test Log on a daily basis. The static pressure needed to be at least negative 0.007 inches w.c. or more negative. If the static pressure of the TTE was found to be less than negative 0.007" w.c., the ID fan waste gate and/or NDO damper were adjusted to achieve the required static pressure. All TTE daily static pressure readings were recorded on the daily test log forms.

5.2.5 Process Data

In addition to test parameters, the following operating parameters were recorded on a daily basis:

- Temperature of the product in the storage tank.
- Percent of capacity of storage tank (where 100% = filled to safe maximum level)

This data can be found in Table 2-3 and also Appendix E of this report.

5.3 Volatile Organic Compounds

The following subsections present the Continuous Emissions Monitoring System (CEMS) criteria for VOC that were adhered to throughout the test program:

5.3.1 Leak Check

Prior to the initiation of testing, the reference method VOC system was leak checked from the end of the sampling probe by ensuring that the system vacuum reached the capacity of the sampling pump

(~20"Hg) while all rotameters indicated no flow. If a leak was detected, it was traced, fixed and the leak check procedure repeated until successful.

5.3.2 System Response Time

Prior to the initiation of sampling, a reference method VOC system response time was determined. During the test program, the system was allowed to sample a minimum of 2.0 times the response time prior to the initiation of any sampling runs.

5.3.3 Calibration Gases

All calibration gases utilized were prepared according to EPA Protocol standards.

5.3.4 Calibration Criteria

- **Calibration Error** – As an initial analyzer calibration procedure, or as necessary following a daily calibration drift check, a calibration error test was conducted for each analyzer channel for the low and mid level gases, as follows. Following instrument calibration (zero and span), the mid and low range calibration gases were injected and the instrument responses recorded. From these values calibration error was calculated for low and mid level gases in accordance with the formula presented below. The maximum allowable calibration error is 5% of the expected value for both the low and mid level gases. If this limit was not achieved, corrective action was taken and the procedure repeated until successful.

$$CalibrationError = \frac{(Concentration_{Response} - Concentration_{value})}{InstrumentSpan} \times 100$$

- **Calibration Drift** – On a daily basis and following the most recent full system calibration error check, a calibration drift test was conducted using zero and a single upscale gases for each analyzer channel. The zero and upscale calibration gases were injected and the instrument responses recorded. From these values, calibration drift was calculated in accordance with the formula presented below. The maximum allowable calibration drift is 3% of instrument span. If this limit was not achieved, the data was considered invalid, corrective action was taken, and full system calibration conducted.

$$Drift = \left| CalibrationError_{final} - CalibrationError_{initital} \right| \times 100$$

5.4 Volumetric Flow Equipment Calibrations

Eastmount's pitot tubes and thermocouples are maintained in accordance with specifications set forth in EPA "Quality Assurance Handbook for Air Pollution Measurement Systems - Volume III Stationary Source Specific Methods" and with manufacturer's suggested procedures. A summary is presented below:

- **Thermocouples** - All type K thermocouples are calibrated against ASTM mercury-in-glass thermometers at three points that bracket the operating temperature of the specific thermocouple. The typical calibration points are an ice bath, ambient air, boiling water, and hot oil.
- **Pitot Tubes** - All Type "S" stainless steel pitot tubes are designed to meet the dimensional criteria set forth in Method 2, therefore a coefficient of 0.84 (Type "S") is used.
- **Pressure Transducers** – All pressure transducers used in this program were calibrated against an inclined manometer at four pressure points.